CLAIMS

What is claimed is:

1. A method of preparing stable, purely synthetic, self-assembling, controlled release, polyethylene oxide (PEO)-based polymersome vesicles having a semi-permeable, thin-walled, amphiphilic, high molecular weight PEO-based block copolymer encapsulating membrane and at least one active agent encapsulated therein, said method comprising:

determining the appropriate blend ratio (mol%) of hydrolysable PEO-block copolymer of at least one hydrophilic component and at least one more hydrophobic PEO-block copolymer component to produce amphiphilic high molecular weight PEO-based polymersomes having a desired controlled release rate of the encapsulated encapsulant;

selecting the at least one hydrolytically degradable, hydrophobic block copolymer to effect controlled polyester chain hydrolysis in the membrane, such that when combined with hydrophilic PEO, the PEO volume fraction (f_{EO}) and chain chemistry control encapsulant release kinetics from the copolymer vesicles and polymersome carrier membrane destabilization; and

blending in aqueous solution said at least one hydrophilic PEO-block copolymer together with the at least one inert, hydrophobic PEG-block copolymer to produce amphiphilic high molecular weight PEO-based polymersomes having the desired controlled release rate of the at least one encapsulant contained therein.

2. The method of claim 1, wherein the polyethylene oxide component of the block copolymer is polyethylene glycol (PEG), or structural equivalent thereof.

3. The method of claim 2, wherein the at least one hydrophilic block copolymer comprises a block copolymer of PEG and a hydrolytically degradable polyester.

4. The method of claim 3, wherein the hydrolytically degradable polyester comprises a high molecular weight polyester of polylactic acid (PLA), which when

combined with PEG forms PEG-PLA, or a high molecular weight polycaprolactone (PCL), which when combined with PEG forms PEG-PCL.

5. The method of claim 1, wherein the at least one inert, non-hydrophilic block copolymer comprises polybutadiene.

6. The method of claim 1, further comprising increasing the mole fraction (mol%) of the at least one hydrolytically degradable block blended into the inert copolymer to directly control release of the encapsulant upon subsequent hydration.

7. The method of claim 6, wherein increasing the block f_{EO} increases rate of transformation into a detergent-like moiety, thereby accelerating destabilization of bilayer morphology of the polymersome membrane and encapsulant release.

8. The method of claim 1, further comprising selecting the at least one polyester for biocompatibility.

9. The method of claim 1, wherein the at least one encapsulant is an amphiphilic or lipophilic composition.

10. The method of claim 1, wherein the at least one encapsulant ranges in molecular weight from less than 10^2 Da to more than 10^5 Da.

11. The method of claim 1, wherein increasing molecular weight of the at least one encapsulant decelerates rate of release from the polymersome carrier, but the f_{EO} and polyester selection primarily dictate release kinetics.

12. The method of claim 9, wherein the at least one encapsulant is a hydrophilic encapsulant encapsulated in the lumen of the polymersome, or the at least one encapsulant is a hydrophilic encapsulant encapsulated by intercalation into the polymersome membrane, or there is more than more encapsulant selected from one or more hydrophilic encapsulants or one or more hydrophobic encapsulants, or a combination thereof.

13. The method of claim 12, wherein at least one hydrophilic encapsulant is selected from the group consisting of carbohydrates, including sucrose; marker-tagged dextrans, including fluorescent dextrans from 1 kD up to 200 kD; therapeutic compositions, including doxorubicin or amphoterican B; dyes; indicators; protein or

protein fragments, including catalase; ammonium sulfate; salts; and gene or gene fragments, including oligonucleotides.

14. The method of claim 12, wherein at least one hydrophobic encapsulant is selected from the group consisting of PKH fluorescent dyes; therapeutic compositions, including taxol and anthracyclin; monosialoganglioside; fluorinated lipids; fluorescein-taxol; and fluorescent-dye modified copolymers.

15. The method of claim 12, wherein the at least one therapeutic composition is an anti-cancer drug selected from cytotoxic doxorubicin and taxol.

16. The method of claim 1, wherein the at least one encapsulant is encapsulated simultaneously with polymersome formation, or subsequent thereto.

17. The hydrolysis triggered, controlled release polymersome produced by the method of claim 1.

18. A method of releasing at least one encapsulant from the polymersome vesicle prepared by the method of claim 1 to an environment immediately surrounding the polymersome, wherein the method comprises:

delivering the polymersome and said at least one encapsulant contained therein to an intended environment, wherein the composition of the environment triggers polyester hydrolysis at a predetermined rate in the polymersome membrane;

transforming membrane bilayer chains into active detergent-like moieties;

triggering induction of pores in the membrane; and thereby

effecting release of said encapsulant.

19. The method of claim 18, wherein said method of release further comprises administering the polymersome to a patient, and releasing said encapsulant from the polymersome to said patient, wherein the polymersome and encapsulant are biocompatible.

20. A method of self-removal of the controlled release polymersome delivered to the patient in claim 19 following release of the encapsulant, comprising further inducing poralation of the membrane to continue until the polymersome is disintegrated.